POWER SUPPLY
INSTRUCTION MANUAL

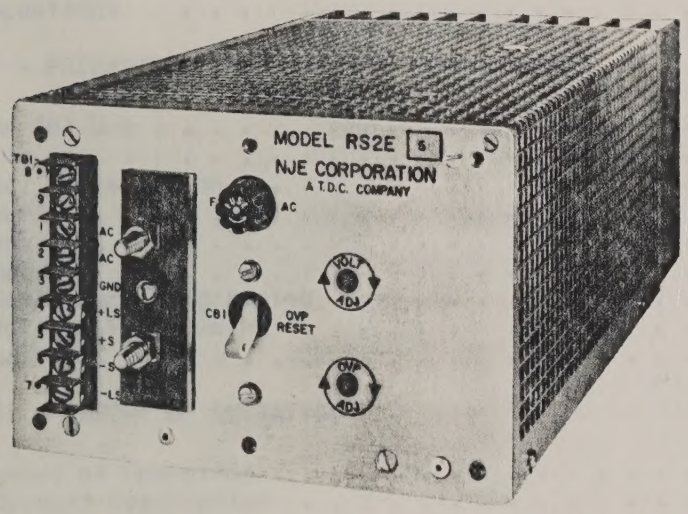
MODEL	RX2E-24-0VP

NJE
PO Box 50, Culver Road
Dayton, N.J. 08810
(201) 329-4611
TWX: 710-480-5674

MODELS RJ, RS2, RX2

D, E, EE SERIES

POWER SUPPLIES



instruction manual

NJE

50 CULVER RD., DAYTON, N.J. 08810 - (201) 329-4611

DWG. NO. 117325-018

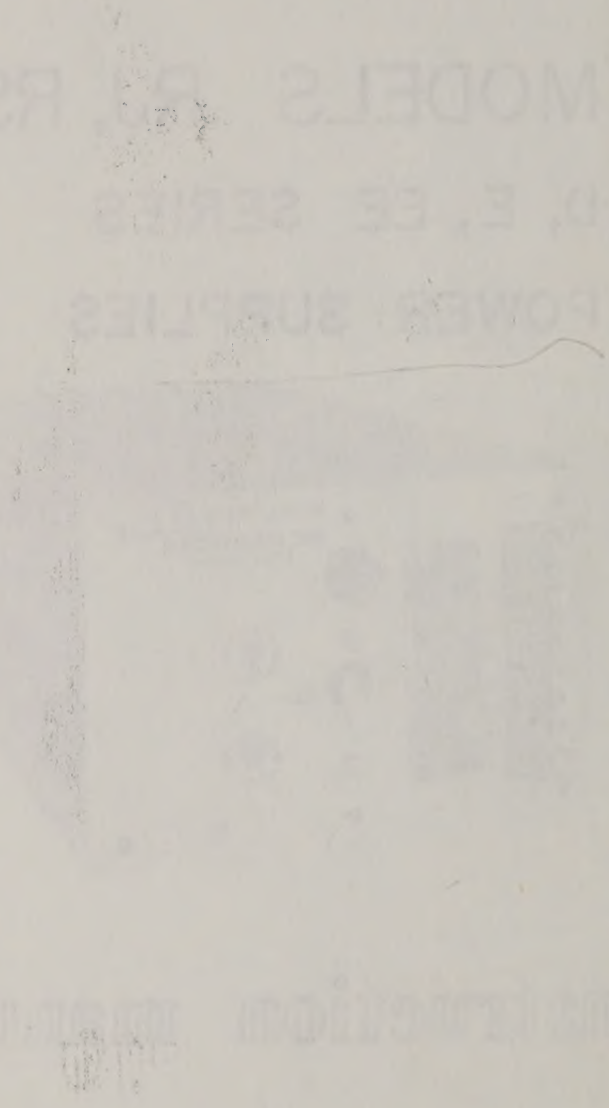


TABLE OF CONTENTS

Paragraph		Page
	SECTION I - INTRODUCTION	
1-1	Scope	1-1
1-2	Function	1-1
1-3	Performance	1-1
1-4	Comparative Specifications	1-1
1-5	Features	1-1
1-6	Environmental Requirements	1-3
1-7	Items Furnished	1-3
1-8	Items Required	1-3
1-9	Warranty Information	1-5
1-10	Safety Precautions	1-5
	SECTION II - PREPARATION FOR USE AND INSTALLATION	
2-1	Preparation for Use	2-1
2-2	Installation	2-1
2-2-1	Mechanical Installation	2-1
2-2-2	DC Connections	2-1
2-2-3	Local Sensing	2-2
2-2-4	Remote Sensing	2-2
2-2-5	Remote Resistance Programming	2-2
2-2-7	Remote Voltage Programming	2-2
2-2-9	AC Connections	2-2
	SECTION III - THEORY OF OPERATION	
3-1	General Theory of Operation	3-1
3-2	Detailed Circuit Description	3-2
	SECTION IV - OPERATING INSTRUCTIONS	
4-1	General Operating Instructions	4-1
4-2	Control Functions	4-1
4-3	Normal Operation	4-1
4-4	Over Voltage Protection	4-1
4-5	Shutdown	4-2
	SECTION V - MAINTENANCE INSTRUCTIONS	
5-1	Routine Maintenance	5-1
5-2	Troubleshooting Instructions	5-1
5-3	Voltage Adjust Setting Procedure	5-1
5-4	Current Limit Setting Adjustment	5-1
5-5	Over Voltage Protection Adjustment	5-4
5-6	Performance Verification	5-5
5-7	Disassembly, Repair, Replacement, Reassembly	5-6
5-8	Packing for Reshipment	5-7
5-9	Storage Instructions	5-7

LIST OF ILLUSTRATIONS

Figure Number		Page
1.	Cable Drop as a Function of Cable Length	a
2.	Local Sensing Connection	a
3.	Remote Sensing Connection	a
4.	Remote Resistance Programming with Local Sensing	b
5.	Remote Resistance Programming with Remote Sensing	b
6.	Remote Voltage Programming with Local Sensing	b
7.	Remote Voltage Programming with Remote Sensing	b
8.	General Circuit Block Diagram	c
9.	Test Connection for Performance Verification	c
10.	Outline and Interface Drawing	d
11.	Parts Placement Diagram	e
12.	Parts Placement, A1 Circuit Card	f
13.	Schematic Diagram	g

LIST OF TABLES

Table Number		Page
1A.	Voltage and Current Ratings, D Series Power Supply	1-2
1B.	Voltage and Current Ratings, E Series Power Supply	1-2A
1C.	Voltage and Current Ratings, EE Series Power Supply	1-2B
2.	Table of Specifications, E Series Power Supply	1-4
3.	Troubleshooting Chart	5-2

APPENDIX

Parts List (Spare)(Optional) . . . . . Rear of Manual

SECTION I

INTRODUCTION

1-1. SCOPE.

This manual is intended for use as a complete guidebook and reference document pertaining to the installation, testing, maintenance, and repair of the NJE D, E, & EE series modular power supply. Complete parts placement drawings, schematic diagram, test voltage, installation diagrams, and troubleshooting chart are included for the installation and maintenance of the D, E, & EE series power supply.

1-2. FUNCTION.

The RS, RS2, and RX2 series D, E, & EE power supply is a self-contained solid state unit operating from the AC line and supplying well-regulated DC voltage and current to electronic equipment. This power supply series is intended for low to medium current applications.

1-3. PERFORMANCE.

The NJE RJ, RS2, and RX2 line of power supplies are all silicon solid state circuits and include the utilization of integrated circuits. Additionally, all supplies are series regulated and are manufactured with high quality industrial grade components. The quality of the power supply is consistent with that required for the most sophisticated computer grade electronic systems in use today. The circuits used are extremely reliable and feature a high degree of simplification. The circuit simplification results in standardization of material and also gives greater reliability due to the reduction of components used in the basic circuits. The overall design philosophy utilized in this product line is based on standardization, simplicity, reliability, and high quality. For the output current ratings and voltages of standard models available in the D, E, & EE series, refer to Table 1A, 1B, and 1C respectively.

1-4. COMPARATIVE SPECIFICATIONS.

Table 2 lists in chart form the specifications of the RJ, RS2, and RX2 models of the D, E, & EE series power supply.

1-5. FEATURES.

1-5-1. OVER VOLTAGE PROTECTION (OVP) (Optional). SCR crowbar to limit maximum output voltage. Normally factory set at 1.5V or 20% (whichever is greater) above the nominal output voltage. OVP may be readjusted by customer via accessible adjustment. (See Maintenance Instructions)

1-5-2. CURRENT LIMITING. Current limiting may be set to limit maximum current from 75% to 125% of rated current. This current limiting adjustment is located internally and can be readjusted by customer. (See Maintenance Instructions)

TABLE 1A

VOLTAGE AND CURRENT RATINGS, D SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJD 2	2± 0.1V	32.5	28.0	23.0	18.0
RS2D5/OVP	5± 0.5V	27.5	23.0	19.0	15.0
RX2D5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RJD5/OVP	5± 0.25V	32.5	28.0	23.0	18.0
RS2D 10	10± 1.0V	20.0	17.0	14.0	11.0
RS2D 12	12± 1.0V	18.0	15.3	13.0	9.9
RX2D 12	12± 0.6V	21.0	17.8	14.7	11.5
RJD 12	12± 0.6V	21.0	17.8	14.7	11.5
RS2D 15	15± 1.0V	15.0	13.0	10.5	8.2
RX2D 15	15± 0.75V	18.0	15.3	13.0	9.9
RJD 15	15± 0.75V	18.0	15.3	13.0	9.9
RS2D 18	18± 1.0V	13.0	11.1	9.1	7.2
RS2D 24	24± 1.0V	10.5	9.0	7.3	5.7
RX2D 24	24± 1.0V	12.5	11.0	8.7	6.8
RJD 24	24± 1.0V	12.5	11.0	8.7	6.8
RS2D 28	28± 1.0V	9.5	8.0	6.6	5.2
RX2D 28	28± 1.0V	11.0	9.0	7.7	6.0
RJD 28	28± 1.0V	11.0	9.0	7.7	6.0
RS2D 48	48± 2.0V	5.0	4.3	3.5	2.8
RX2D 48	48± 2.0V	6.5	5.5	4.6	3.6

Notes:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

TABLE 1B

VOLTAGE AND CURRENT RATINGS, E SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJE 2	2± 0.1V	41.0	34.0	29.0	22.0
RS2E 5/OVP	5± 0.5V	35.0	30.0	24.0	20.0
RX2E 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RJE 5/OVP	5± 0.25V	41.5	34.0	29.0	22.0
RS2E 10	10± 1.0V	24.5	20.8	17.2	13.5
RS2E 12	12± 1.0V	22.5	19.1	15.7	12.3
RX2E 12	12± 0.6V	27.0	23.0	19.0	15.0
RJE 12	12± 0.6V	27.0	23.0	19.0	15.0
RS2E 15	15± 1.0V	19.0	16.0	13.3	10.4
RX2E 15	15± 0.75V	23.0	20.0	16.0	13.0
RJE 15	15± 0.75V	23.0	20.0	16.0	13.0
RS2E 18	18± 1.0V	15.0	12.8	10.5	8.3
RS2E 24	24± 1.0V	13.5	11.5	9.4	7.4
RX2E 24	24± 1.0V	15.5	13.0	11.0	8.5
RJE 24	24± 1.0V	15.5	13.0	11.0	8.5
RS2E 28	28± 1.0V	12.0	10.0	8.4	6.6
RX2E 28	28± 1.0V	14.0	12.0	9.8	7.7
RJE 28	28± 1.0V	14.0	12.0	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. DC output voltage regulated for line and load.

TABLE 1C

VOLTAGE AND CURRENT RATINGS, EE SERIES POWER SUPPLY

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE			
		40°C	50°C	60°C	71°C
RJEE 2	2V± 0.1V	44.5	37.8	31.1	24.4
RS2EE 5/OVP	5V± 0.5V	44.5	37.8	31.1	24.4
RX2EE 5/OVP	5V± 0.25V	52.5	44.6	36.7	28.8
RJEE 5/OVP	5V± 0.25V	60.0	51.0	42.0	33.0
RS2EE 12	12V± 1.0V	29.0	24.6	20.3	15.9
RX2EE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RJEE 12	12V± 0.6V	34.0	28.9	23.8	18.7
RS2EE 15	15V± 1.0V	24.5	20.8	17.1	13.4
RX2EE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RJEE 15	15V± 0.75V	29.0	24.6	20.3	15.9
RS2EE 24	24V± 1.0V	17.0	14.5	11.9	9.3
RX2EE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RJEE 24	24V± 1.0V	20.0	17.0	14.0	11.0
RS2EE 28	28V± 1.0V	15.0	12.7	10.5	8.2
RX2EE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RJEE 28	28V± 1.0V	18.0	15.3	12.6	9.9
RS2EE 36	36V± 1.5V	12.0	10.2	8.4	6.6
RX2EE 36	36V± 1.5V	14.0	11.9	9.8	7.7

NOTES:
1. Current range must be chosen to suit the appropriate maximum ambient temperature.
2. Current ratings apply for entire voltage range.
3. D.C. output voltage regulated for line and load.

1-5-3. REMOTE PROGRAMMING. 1 volt per volt or 500 ohms per volt (output terminal strip). See Section II for detailed connection information to operate supply in remote programming mode.

1-5-4. REMOTE SENSING. Sensing terminals separate from the load terminals provide regulation of the voltage at the load rather than regulation of the voltage at the power supply output terminals. This eliminates loss of load regulation due to the voltage drop in the wires connecting the supply to the load.

1-5-5. FAULT PROTECTION. All power supplies are protected with primary fuses and/or circuit breakers.

1-5-6. MISCELLANEOUS FEATURES. The following features are optionally available on these series power supplies: terminal board cover for input connection protection; line cord (3-wire, U-ground); special RMS input voltages with nominal values of 208, 220, 230, and 240 - range is ±10%.

1-6. ENVIRONMENTAL REQUIREMENTS.

The D, E, & EE series power supply is designed to be operated in a free-air (convection) mode. Special cooling and/or forced air (blower or fan) is not required for normal room temperature installations. Room temperature is considered to be nominal at 25° centigrade. However, should the power supply be operated in an ambient environment greater than 40° centigrade, the current output of the supplies must be derated at the rate of (1.5%/°C) up to a maximum ambient operating temperature of 71° centigrade. These series power supplies are commercial-grade equipments intended for fixed ground installation and should not be subjected to extreme adverse conditions of shock, vibration, or salt spray, etc.

1-7. ITEMS FURNISHED.

The D, E, & EE series power supply is furnished complete and pretested and is ready to install using the 8-32 mounting holes provided. Consult the Preparation for Use and Installation section of this manual for installation instructions.

1-8. ITEMS REQUIRED.

Required to put the D, E, & EE series power supply in operation is a suitable 3-wire, U-ground receptacle supplying 115VAC, 60 hertz nominal (except in the case of supplies operated from 187 to 264 VAC line). Wattage requirements are given in Table 2. A line cord will be necessary between power supply and receptacle, unless the line cord option is equipped. Interconnecting wiring from the power supply and equipment being powered is required as determined by the end usage of the power supply. Stranded wire insulated with PVC or teflon covering is recommended for interconnecting wiring and it is recommended that shielded cable be used for sense leads between supply and load if remote sensing is desired. (See Section II for explanation of remote sensing.) Refer to Figure 1 for determination of proper wire size required for the load connections. Additionally, 8-32 x 3/8 long mounting screws are required to fasten the power supply in place.

TABLE 2

TABLE OF SPECIFICATIONS, D, E, & EE SERIES POWER SUPPLY

SPECIFICATION	RS2	RX2	RJ
INPUT REQUIREMENTS	105-132V RMS @ 47-440 HZ.	*105-125V RMS @ 57-63 HZ.	105-125V RMS @ 47-440 HZ.
REGULATION			
MIN-MAX LINE	0.01% + 1 mV	0.1% + 1 mV	0.1% + 1 mV
NO LOAD TO FULL LOAD	0.01% + 1 mV	0.1% + 1 mV	0.1% + 1 mV
RIPPLE AND NOISE	1.0 mV RMS; 3 mV P-P		
TEMPERATURE RANGE			
OPERATING	-20°C to +71°C	0°C to +71°C	0°C to +71°C
STORAGE	-55°C to +85°C	-55°C to +85°C	-55°C to +85°C
STABILITY (LONG TERM DRIFT)	0.1% (24Hr. PERIOD, AFTER 1/2Hr. WARM-UP)		
TRANSIENT RECOVERY TIME	50 MICROSECONDS TO 0.1%		
OVERSHOOT (OUTPUT)	NONE ON TURN-ON OR TURN-OFF		
OVERCURRENT PROTECTION	CURRENT FOLDBACK ADJUSTABLE 75-125% OF OUTPUT RATING		
REMOTE PROGRAMMING			
RESISTANCE	500 OHMS PER VOLT (OR)		
VOLTAGE	1 VOLT PER VOLT		
REMOTE SENSING	PROVIDED		
INPUT PROTECTION	FUSE IN HOLDER AND CIRCUIT BREAKER ON FRONT PANEL		
CONNECTIONS	CINCH 140 TERMINAL BLOCK ON FRONT FOR ALL CONNECTIONS. 1/4-20 OUTPUT STUDS ON FRONT FOR POWER CONNECTIONS		
CONTROLS			
VOLTAGE ADJUST	SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL		
OVP ADJUST	SCREWDRIVER ACCESS HOLE LOCATED ON FRONT PANEL		
FINISH	GOLD IRRIDITE ALUMINUM CHASSIS AND HEAT SINKS		
MOUNTING	8-32 TAPPED MOUNTING HOLES PROVIDED ON THREE SURFACES FOR D & E, TWO SURFACES FOR EE		
COOLING	NORMAL CONVECTION COOLING, NO EXTERNAL HEAT SINKS REQUIRED		
SIZE	D	E	EE
	4-29/32" x 7-1/2" x 9-51/64"	4-29/32" x 7-1/2" x 11-3/4"	4-29/32" x 7-1/2" x 16-1/2"
WEIGHT	21 POUNDS	24 POUNDS	31 POUNDS
INPUT POWER REQUIREMENTS	460 VOLT-AMPS	600 VOLT-AMPS	850 VOLT-AMPS

* Units may be operated at 47-53 HZ. by derating to the next highest temperature range. See Table 1A, 1B, or 1C.

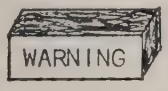
1-9. WARRANTY INFORMATION.

All NJE products listed in this manual are warranted against defects in material and workmanship for FIVE YEARS from date of shipment. This warranty is limited to the cost of parts and labor to restore units to the original factory condition. All shipping costs associated with the units to be repaired and any return shipment damages are the responsibility of the customer. NJE will not be responsible for any failure where the power supply has been used in an application for which it has not been designed or intended. If this power supply is sold to a manufacturer who is using it in a system, as an OEM buyer, which he is reselling, the guarantee above is transferable to the end user.

NOTE: Power supply(s) should not be returned to the factory for inwarranty repair unless the unit remains inoperable after referring to the troubleshooting section of this manual, and carrying out the instructions therein. For repair service or advice concerning an application problem, please contact the factory.

1-10. SAFETY PRECAUTIONS.

HAZARDOUS VOLTAGES. The D, E, & EE series power supplies are powered by 115 volt AC* line voltage which is a hazardous voltage to maintenance personnel. It is recommended the power supply be installed mechanically and the DC output connections be installed prior to plugging in the AC line cords. No hazardous voltages are present to the operator of the equipment during normal usage.



Observe proper safety procedures for 115 volt AC* levels when troubleshooting or servicing these series power supplies.
* (Optional inputs are higher)

Service and troubleshooting should only be performed by a qualified technician.

SECTION II

PREPARATION FOR USE AND INSTALLATION

2-1. PREPARATION FOR USE.

The power supply is shipped in a cardboard carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The power supply was checked electrically and mechanically before it left the factory, and is warranged to be in perfect operating condition. This guarantee does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed, or missing parts, should be brought to the attention of the transportation company and a claim should be entered. The literature packed with the supply should be removed and held for reference in operating the equipment. Refer to Figure 10 for an outline drawing of the D, E, & EE series power supply showing assemblies and controls.

2-2. INSTALLATION.

Do not attempt to operate the power supply if obvious mechanical damage has occurred. If the power supply has not sustained any shipping damage it may be installed.

NOTE

Make all connections to the system before applying power.

2-2-1. MECHANICAL INSTALLATION. Mount the power supply mechanically in its cabinet; usually with the equipment to be powered. Standard procedure is to mount the power supply(s) at the bottom of the rack cabinet, but this is not mandatory provided the ventilation requirements of paragraph 1-6 are met. Support the power supply while fastening it in place using four (4) or six (6) screws which must be provided. The power supply mounts by any of 2 or 3 surfaces as shown in Figure 10. Mounting screws should be 8-32 thread, no longer than 3/8" and snugged down tightly (minimum of 10 in-lbs. torque).

2-2-2. DC CONNECTIONS. A pair of 1/4-20 threaded output studs are provided at the front of the D, E, & EE series power supply. Lugs should be attached to the power connection wires prior to fastening to the output studs. Determination of correct wire size for power connections may be made by consulting Figure 1.

NOTE

Do not operate the power supply <u>with</u> the positive and negative sensing leads disconnected either remotely or locally.

2-2-3. LOCAL SENSING. The power supply is shipped in the local sensing mode. The local sensing mode is illustrated in Figure 2. In this mode, the power supply regulates the voltage at the output terminals and does not account for voltage drop between the output terminals and load. Should optimum regulation at the load be desired, the power supply may be connected in the remote sensing mode. This and other useful operating modes are described in Section 2-2-4 through 2-2-8.

2-2-4. REMOTE SENSING. In the remote sensing mode, the supply voltage is regulated directly at the load terminals. As a result, regulation is not affected by the voltage drops in the leads connecting the power supply to the load. The remote sensing mode is illustrated in Figure 3. It is recommended that the sensing wires between TB1-5 and 6 to the load be a shielded twisted pair of 20 gauge AWG size.

2-2-5. REMOTE RESISTANCE PROGRAMMING WITH LOCAL SENSING. The remote resistance programming with local sensing mode allows the user to vary the output voltage of the supply without proximity to the power supply. The load regulation is subject to load connection cable voltage drop. The remote resistance programming with local sensing mode is illustrated in Figure 4. It is recommended that the wires between the power supply TB1-6 and 7 to the remote resistance be a 20 gauge AWG shielded twisted pair.

2-2-6. REMOTE RESISTANCE PROGRAMMING WITH REMOTE SENSING. Remote resistance programming with remote sensing allows the user to vary the output voltage of the supply without direct proximity to the supply while maintaining consistent load regulation unaffected by load connection cable voltage drop. This mode of operation is illustrated in Figure 5. It is recommended that the wires from the power supply to the remote resistance and from the remote resistance to the load be a 20 gauge AWG shielded twisted pair.

2-2-7. REMOTE VOLTAGE PROGRAMMING WITH LOCAL SENSING. Remote voltage programming with local sensing allows the user to vary the output voltage of the supply without proximity to the supply. The aforementioned is accomplished by utilizing a programming voltage. The load regulation is subject to load connection cable drops. This mode of operation is illustrated in Figure 6. It is recommended that a 20 gauge AWG shielded twisted pair be used to connect the power supply TB1-6 and 7 to the remote programming voltage.

2-2-8. REMOTE VOLTAGE PROGRAMMING WITH REMOTE SENSING. Remote voltage programming with remote sensing allows the user to vary the output voltage of the supply without proximity to the supply while maintaining consistent load regulation. The output voltage of the power supply if varied utilizing a remote voltage source. The load regulation is not subject to load connection cable voltage drop in this mode of operation, which is illustrated in Figure 7. It is recommended that the wiring from power supply to remote voltage source and from source to load be a 20 gauge AWG shielded twisted pair.

2-2-9. AC CONNECTIONS. Install a line cord with minimum 16 gauge AWG wire with ground to the terminals marked AC, AC, and GND on TB1 at the front of the supply, unless the supply is ordered with the line cord option. Plug this cord into a grounded, 115 VAC, 60 hertz receptacle. Special voltage input power supplies may be provided with a plug and receptacle at the user's discretion, such as a TWIST-LOK plug for 230 VAC. The power supply is now ready to be operated.

SECTION III

THEORY OF OPERATION

3-1. GENERAL THEORY OF OPERATION

The input AC is applied through the fuse and the circuit breaker switch* to the primary of the power transformer. AC from the load power secondary is rectified and capacitive filtered to provide the raw DC voltage for the series pass section. This voltage is also peak rectified and filtered in the boost circuit to provide a higher voltage level for the driver(s) on some units. A separate bias winding on the power transformer provides AC voltage which is rectified and filtered to power the control circuitry.

The control circuitry contains an error amplifier and a reference voltage within a 723 Integrated Circuit Regulator. The output voltage is compared to the reference voltage and the error amplifier corrects for any difference. The correction will always oppose any change in the output voltage caused by either input line or output load variation.

The output current is sensed in the pass section and if a pre-set limit is reached the current limiter stage will inhibit the amplifier output and reduce the load current as the load demand is increased (load resistance decreased). This sensing is of the fold back type which lowers the point of current limit as the output voltage falls.

The over voltage protection circuitry is connected directly across the output terminals and senses the output voltage. If this voltage exceeds a pre-set level, a silicon controlled rectifier (SCR) is triggered on which crowbars the output and opens the primary circuit breaker, protecting the load, the supply, and the power line. (For OVP Option)

3-2. DETAILED CIRCUIT DESCRIPTION.

The following descriptions list the components used in these series power supplies and the function of each component used. Refer to the schematic and parts placement drawing at the rear of this manual for specific component location (Figures 11, 12, and 13).

3-2-1. MAIN ASSEMBLY COMPONENTS.

COMPONENT	FUNCTION
* CB1	Interrupts AC power to the primary winding of T1 when OVP network is activated. (With OVP Option only)
F1	Fuse. Protects supply from excessive current conditions.
T1	Power transformer. Electrostatic shielded, vacuum impregnated with epoxy varnish.
C2A, C2B	Main filter capacitors. Reduces ripple voltage to pass section. (C2B not on all units)

COMPONENT	FUNCTION
R1	Bleeder resistor. Provides discharge current path for main filter capacitors.
TH1	Protects the power supply from failing during an overheated condition by opening the transformer primary circuit (Optional).

3-2-2. A1 CIRCUIT CARD COMPONENTS.

COMPONENT	FUNCTION
R1	Limits the current through CR5.
R2	Current limiting resistor for protection of IC1.
R3	Absorbs Icbo of Q2 to prevent thermal runaway.
R4	Variable portion of current limiting network, consisting of R4 and R5.
R5	Fixed portion of current limit network. Determines the minimum value of load current that the circuit will current limit.
R6	Absorbs Icbo of pass transistors Q1A-Q1D or Q1E or Q1F.
R9	Determines the fold back characteristics.
R10	The resistive portion of the RC network that provides current limit delay at turn-on.
R11	Limits current to the base of Q5.
R12	The fixed portion of the voltage divider in the OVP triggering network. (OVP Option)
R13	Limits gate current to SCR1. (OVP Option)
R14	Determines the minimum triggering voltage of the OVP network. (OVP Option)
R15	Variable portion of voltage divider that determines OVP trip level. (OVP Option)
R16	Prevents false triggering of SCR1. (OVP Option)
R17	Output bleeder resistor. Provides discharge current path for C7.
R18	The resistive portion of the RC network that provides frequency compensation for IC1.

COMPONENT	FUNCTION
R19	Forms a voltage divider with R20 to provide a reference voltage at pin 4 of IC1 with respect to pin 7 of IC1.
R20	See R19.
R21	Provides a constant current (approx. 2mA) for the programming resistors R22 and R23.
R22	The fixed portion of the programming resistors. Determines the minimum output voltage level.
R23	The variable portion of the programming resistor network that determines the output voltage level.
R24	Limits the maximum current and reduces the power dissipation of Q6.
R25	Absorbs Icbo of Q6.
R26	Limits the output voltage variation when the positive sense lead is removed. (Normally by-passed when positive sense lead is connected.)
R28	Provides stabilization in conjunction with C9.
R29	In conjunction with C6, improves transient response and reduces output ripple.
R30	Limits voltage to Q6 and limits power dissipation of Q6. (Not used on all models.)
R32	Current limit resistor. Limits surge through CB1 and SCR1 when power supply goes into OVP mode. (OVP Option)
R33	Provides path for bias current flow of CR4.
C1	Filter capacitor for bias supply. (Not used on all models.)
C3	The capacitive portion of the RC network that provides frequency compensation for IC1.
C4	Provides current limit delay at turn-on.
C5	Delays the response of the OVP circuit to prevent false triggering. (OVP Option)
C6	In conjunction with R29, improves transient response and reduces output ripple.
C7A-C7C	Output capacitors. Reduces output noise and provides closed loop stabilization. (C7B and C7C not used on all models.)
C8	Reduces noise at reference portion of IC1. Prevents voltage overshoot at turn-on.

COMPONENT	FUNCTION
C9	Provides stabilization in conjunction with R28. (Not used on all models.)
C10	Filter capacitor for bias supply. (Not used on all models.)
C11	Provides stability during remote sense operation. (Not used on all models.)
C12	Provides stabilization of the current limit circuit.
C13	Prevents turn-on overshoot.
CR1	Rectifier. Provides DC voltage for bias circuit. (Not used on all models.)
CR2	Rectifier. Same as CR1.
CR3	Provides temperature compensation for the current limit transistor, Q5.
CR4	Zener diode. Provides reference voltage for OVP network. (OVP Option)
CR5	12 volt zener diode. Provides regulated voltage for IC1.
CR6	Isolates unregulated voltage from the output. Conducts current through SCR1 to short circuit the output during OVP operation. (OVP Option)
CR7	Bridge rectifier. Provides DC voltage to bias circuit. (Not used on all models.)
Q3	Provides drive from IC1 to Q6.
Q4	OVP transistor. Provides a gate signal to SCR1 during OVP conditions. (OVP Option)
Q5	Current limit transistor. During current limit Q5 conducts, thus decreasing the available output voltage of IC1.
Q6	Current amplifier. Provides base drive to Q2 of A2 Assembly.
SCR1	Silicon Controlled Rectifier. Crowbars circuits output during OVP mode. (OVP Option)
IC1	723 voltage regulator integrated circuit. Provides reference and control circuitry for regulator loop.

3-2-3. A2 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
R7A-R7G	Emitter resistors. Provides current sharing of Q1A-Q1G. Also used for current limit sense resistors. (E, F, & G some models only)

COMPONENT	FUNCTION
Q1A-Q1G	Pass transistors. Connected in parallel for current sharing. (E, F, & G some models only)
Q2	Driver transistor. Provides current amplification for pass stage.

3-2-4. A3 HEAT SINK ASSEMBLY.

COMPONENT	FUNCTION
CR1-CR2	Power rectifiers. Provides full wave rectified DC voltage to pass section.
C1	Suppresses commutation spikes.

3-2-5. uA 723 IC PIN DESIGNATION.

PIN NUMBER	FUNCTION
1.	No connection.
2.	Internal current limit - not used.
3.	Internal current limit - not used.
4.	Inverting input.
5.	Non-inverting input.
6.	Reference voltage - nominal 7.1 VDC.
7.	Common.
8.	No connection.
9.	Not used.
10.	Output.
11.	Input voltage to output stage of IC.
12.	Input voltage to low level stages of IC.
13.	Frequency compensation and external current limit control of IC.
14.	No connection.

SECTION IV

OPERATING INSTRUCTIONS

4-1. GENERAL OPERATING INSTRUCTIONS.

The RJ, RS2, and RX2 D, E, & EE series power supply has a minimum of controls and is not difficult to operate. All controls used in normal operation are placed on the front panel and input/output connections are also at the front. The supply may be turned on and off with the circuit breaker on the front panel. All control adjustment procedures are detailed in Section V, Maintenance Instructions.

4-2. CONTROL FUNCTIONS.

The front panel of the D, E, & EE series power supply contains an input terminal board, output terminals, a circuit breaker switch (with OVP only), fuse holder, and voltage adjust control. Also on units equipped with OVP there is an OVP set point adjust control. The function of each of these components follows:

1. CIRCUIT BREAKER. Interrupts AC power to the primary winding of the transformer when OVP network is activiated. Also used as an on/off switch for the power supply. Protects the power supply (and gives visual indication) during over voltage protection.

2. FUSE HOLDER. Contains primary circuit fuse which protects power transformer (and supply) from catastrophic failure.

3. OVP ADJUST POT. Screwdriver adjustment provided on units with OVP option to set over voltage protection set point.

4. VOLTAGE ADJUST POT. Screwdriver adjustment provided to set output voltage within its normal range. See Table 1 for voltage adjust ranges available on standard units.

4-3. NORMAL OPERATION.

Consult Section II for preparation for use and installation instructions. After the power supply is installed, place the circuit breaker in the * upward or "on" position to operate the unit. No initial adjustments are required. (* OVP Option units only)

4-4. OVER VOLTAGE PROTECTION. (OPTIONAL)

If a voltmeter across the supply output registers between 1.0 and 1.5 volts DC, the supply may be in the OVP mode. The output protection crowbar circuit has tripped due to an over voltage condition at the output terminals caused either internally or externally to the power supply. The power supply may be reset to normal operation by turning the circuit breaker to the off position and turning back on (up position) after one or two seconds. Failure of the supply to attain rated output voltage after trying this procedure is a fault condition and the operator should refer to paragraph 5-2, Trouble-shooting Instructions.

4-5. SHUTDOWN.

No special procedure is required for power supply shutdown. Flipping the circuit breaker down to the "OFF" position turns off the supply. For units without a circuit breaker (no OVP Option) removing power to the AC input on TB1-1 and 2 turns off the power supply.

SECTION V

MAINTENANCE INSTRUCTIONS

5-1. ROUTINE MAINTENANCE.

The only routine maintenance of the RJ, RS2, and RX2 D, E, & EE series power supply necessary is cleaning. For other than routing maintenance, refer to paragraph 5-2, Troubleshooting Instructions and paragraph 5-7, Disassembly, Repair, Replacement, Reassembly. The D, E, & EE series power supplies are designed for years of trouble-free service. The only physical maintenance required is once or twice per year (depending on how dirty the environment in which they are mounted) the power supply should be cleaned of dust which may accumulate. Since the power supply is convection cooled, a great accumulation of dust on the perforated dust cover and rear heat sink may in time hinder the free flow of cooling air. This dust accumulation may be removed with a brush or vacuum cleaner with a brush attachment.

5-2. TROUBLESHOOTING INSTRUCTIONS.

Table 3 lists possible equipment malfunctions which may occur to the D, E, & EE series power supply during normal operation. The Table gives symptom, possible cause, and remedy to restore equipment to normal operation. When trouble occurs, systematically check all fuses, primary power lines, and external circuit elements and wiring for malfunction before troubleshooting the power supply equipment. Malfunctions can often be traced to simple causes such as improper sensing, connections, or fuse failure due to fatique.

5-3. VOLTAGE ADJUST SETTING PROCEDURE.

The voltage adjust pot is a screwdriver adjust pot located on the front panel. To adjust, turn the pot with a standard flat screwdriver clockwise to increase voltage and counter-clockwise to decrease voltage. Observe output voltage reading on a test voltmeter and set pot to obtain desired output voltage.

5-4. CURRENT LIMIT SETTING ADJUSTMENT.

The correct setting of the current limit adjust pot (see shcematic and parts placement drawings for location of this control) is such that the supply will begin to fold back its output voltage when output current reaches 120% of rated 40°C current. See Table 1 for correct rated current value.

NOTE

Setting the current limit too close to the nominal current will give poor load regulation.

5-4-1. CURRENT LIMIT ADJUSTMENT PROCEDURE.

The adjustment procedure requires that the power supply module is disconnected from associated equipment, is at an ambient temperature of 25-30°C, and has not been operated with load for at least one hour. Whenever rated output of the supply module cannot be attained, adjust the current limit pot as follows: (see page 5-4)

TABLE 3

TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
No output voltage.	No AC input.	Line cord frayed or pinched - replace.
		AC receptacle inoperative - check line fuses or breaker.
	Blown fuse, F1.	Check fuse F1 on front panel.
	Faulty wiring.	Check output connections for tightness on TB1, E1, and E2.
		Check output cables to equipment being powered for shorts or open leads.
	Faulty rectifiers.	Check main rectifiers CR1 and CR2 for presence of voltage. Rectifiers may be shorted if no voltage present. Likewise check for voltage at emitter of pass transistors Q1A-Q1G. Replace open or shorted components.
	Faulty regulator IC1.	Replace regulator EC1 if above steps do not return output voltage to normal.
Output voltage low.	Power supply operating in current foldback mode.	Remove load, check load value and check for shorts and/or improper supply-load connections.
	Power supply in over voltage protection mode. (OVP Option)	Turn AC circuit breaker off, turn on after one or two seconds.
		If output does not come up, check OVP adjust setting. (See paragraph 5-5.)
		If OVP is set at max and output does not come up, check OVP circuit components: A1-CR4, A1-Q4, A1-SCR1, A1-CR6.
	Faulty current limit transistor A1-Q5	Check current limit transistor for short, replace.
	Voltage regulator IC1 loose.	Check IC1 for tightness in socket.

TABLE 3 - TROUBLESHOOTING (CONT'D) (Sheet 2 of 2)

SYMPTOM	POSSIBLE CAUSE	REMEDY
Cannot adjust output voltage.	Damaged voltage adjust control pot R23.	Check voltage adjust pot R23 on front panel for short or open, replace as required.
	Module operating as constant current source at current limit value.	Remove load, check load value and check for shorts and/or improper supply-load connections.
Output voltage too high.	Improper output terminal connections.	Check output sensing connections from TB1.
	Shorted pass transistor(s) Q1A-Q1G.	Check pass transistor(s) Q1A-Q1E for short, replace if necessary.
Poor voltage regulation.	Loose load connections.	Check supply-load connections.
	Improper sensing connections.	Check supply-load voltage sensing connections. See Section 2-2.
	Voltage regulator IC1 loose.	Check that voltage regulator IC1 is tight in socket.
	Faulty voltage regulator IC1.	Replace IC1 if above steps do not help.
	Power supply in current limiting mode.	Check that the load current does not exceed rating per Table 1. Refer to Section 5-4-1 if any adjustment is required.
High ripple on output.	Improper ground connections.	Ground positive or negative output terminal at the module.
	Faulty filter capacitor(s) C2A and/or C2B.	Check rectifier diodes for short if ripple is over 2 volts, replace if shorted.
Power supply overheats.	Output current too high.	Check that output current does not exceed rated value (See Table 1). If over, check load requirement.
	Poor ventilation.	Check power supply dust cover and cooling holes (and fins where applicable) for blockage by dust or improper installation. (See Section 1-6.)

1. Determine current limit pot designation by referring to schematic in Figure 12. Locate this pot on the module A1 circuit.

2. Remove AC power from power supply system and gain access to current limit pot by removing module cover.

3. Connect power supply for constant voltage with local sensing as shown in Figure 9.

4. Turn voltage adjust control on front panel to minimum output voltage.

5. Apply a resistor load to output terminals so that output current is 120% of 40°C rating of unit. Refer to Table 1, Voltage and Current Ratings for correct rated output current.

6. Using an oscilloscope, Taktronix 503 or equivalent, observe output voltage of supply while adjusting current limit pot in a counter-clockwise direction. Adjust until output ripple increases sharply and oscilloscope pattern changes.

7. Recheck setting by increasing load from rated value to 120% of rated value and observing oscilloscope for sharp increase in output ripple at 120% point. Repeat procedure if necessary.

8. Reassemble top cover.

5-5. OVER VOLTAGE PROTECTION ADJUSTMENT.

The correct setting of the over voltage protection pot (located on the front panel of the supply) is 1.5V or 20% (whichever is greater) above nominal reated output voltage of the supply. Refer to Table 1 for correct output voltage of the unit.

5-5-1. OVP ADJUSTMENT PROCEDURE. (ON UNIT WITH OVP OPTION ONLY)

The adjustment procedure requires that the power supply be disconnected from associated equipment.

1. The OVP pot is on the front panel of these series power supplies.

2. Turn the OVP adjust pot fully clockwise. The correct OVP setting is 1.5V or 20% (whichever is greater) above nominal rated output voltage of the module being adjusted. Refer to Table 1.

3. Turn on the power supply and raise the output voltage to this desired over voltage protection point. Monitor output voltage by connecting an external voltmeter to the output of the supply and raise voltage by adjusting front panel volt adjust pot. Some units will require an external voltage source to set the OVP at the desired voltage.

4. Slowly turn the OVP pot counter-clockwise until the voltmeter suddenly drops to between 1 and 1.5 volts and CB1 (OVP reset) trips indicating that the over voltage protection point is reached.

5. The over voltage protection point is now set. Turn down voltage adjust pot before turning on power supply again.

6. Turn on supply and reset output voltage to correct nominal value. Refer to Section 5-3 for specific voltage adjust setting procedures.

5-6. PERFORMANCE VERIFICATION.

It may be necessary to check the performance of these series power supplies periodically. Specific parameters of performance are given for each of the power supply models in these series in Table 2, Table of Specifications. The power supply parameters may be verified with the test set up illustrated in Figure 9. This testing is to be performed by a trained electronic technician utilizing the following equipment (or equivalent).

1. A variable resistor load appropriately rated for the model being tested.

2. A DC ammeter, 0 to 50 amps, ±2% accuracy.

3. An AC ammeter, 0 to 10 amps, ±2% accuracy.

4. An RMS voltmeter, Ballantine model 320 or equivalent.

5. A digital voltmeter (DVM), Data Precision 902 or equivalent.

6. An AC variac, switched, with grounded 3-wire receptacle, capable of supplying 10 amps AC.

7. An AC voltmeter, 0 to 150 VAC, ±5% accuracy.

8. An oscilloscope, Tektronix model 503 or equivalent.

9. A 5-position terminal board to make connections to the power supply under test.

5-6-1. LINE REGULATION.

Turn on power supply and load to full rated current at 40°C, as listed in Table 1. Measure and record the output voltage of the supply using the DVM at 105 volts AC input. Turn up the variac to 132 volts AC input (for RS2D, E, & EE supplies) to the supply; measure and record output voltage. The difference between these output readings should not exceed 0.01% + 1mV of the maximum reading noted, or 0.1% + 1mV of the maximum reading noted for RX2D, E, & EE and RJD, E, & EE supplies, with a line swing from 105-125 VAC.

5-6-2. RIPPLE.

Measure the RMS ripple on the output of the supply using the RMS voltmeter with the supply at full load as determined in paragraph 5-6-1, and at nominal AC input voltage. Ripple on the DC output should not exceed 1.0 millivolts RMS.

5-6-2. NOISE.

Measure noise on the output of the power supply using the oscilloscope with the supply at full load as in paragraph 5-6-2. Noise should not exceed 3.0 millivolts peak-to-peak.

5-6-3. LOAD REGULATION.

With the supply at nominal input AC voltage, load to full rated current as determined by Table 1; measure and record the output voltage on the DVM. Remove the load and measure and record output voltage. The difference between these readings should not exceed 0.01% + .1mV of the maximum reading obtained for RS2D, E, & EE supplies; or 0.1% + 1mV of the maximum reading for RX2D, E, & EE and RJD, E, & EE supplies.

5-6-4. OVER VOLTAGE PROTECTION CHECK.

The over voltage protection circuit may be checked on the supply while in the test set-up of Figure 9. Refer to paragraphs 5-5 and 5-5-1 for OVP check and reset procedure.

5-6-5. CURRENT LIMITER CHECK.

The power supply current limiter circuit may be checked using the test set-up of Figure 9. With supply on and nominal AC input voltage applied, set the output voltage at minimum, load the supply to full load as in paragraph 5-6-1. Increase load current (decrease load resistance) slowly until the output voltage begins to drop. This is the current limit point. The current limit point or point where output voltage begins to drop should be approximately 120% of the rated output current at 40°C.

5-6-6. DEVIATIONS.

Any deviations from standard as noted in paragraphs 5-6-1 through 5-6-5 when performing any or all tests described may constitute a power supply failure. Refer to paragraph 5-2, Troubleshooting Instructions for possible causes and remedy of power supply failure.

5-7. DISASSEMBLY, REPAIR, REPLACEMENT, REASSEMBLY.

NOTE

Repair in excess of those indicated in Table 3, Troubleshooting, may jeopardize the warranty. Therefore, consult the factory with details for any extraordinary repair that may be required.

Repair of the D, E, & EE series power supply will be limited to replacing defective components found in performance of Maintenance and Troubleshooting techniques as described in paragraphs 5-1 and 5-2, respectively. For location of specific parts and assemblies, please refer to the Parts Placement Diagrams, Figures 11 and 12.

5-7-1. DISASSEMBLY. Disassemble parts in a logical fashion and save all hardware including locking washers so that it may be reassembled as it was taken apart. There are four (4) screws holding the power supply cover. There are five (5) screws holding the A1 circuit card in place which are removed from the front of the unit.

5-7-2. REPAIR, REPLACEMENT. Repair of the power supply and its components is limited to replacement of defective components with new ones and testing as described in paragraph 5-6, Performance Verification. When working with the printed circuit board contained within the power supply, the following techniques should be adhered to if it becomes necessary to change components.

1. Always use a heat sink when soldering transistors and diodes.

2. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

3. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process. Place the wick onto the soldered connection and apply soldering iron onto the wick, freeing the component, simultaneously remove iron and wick.

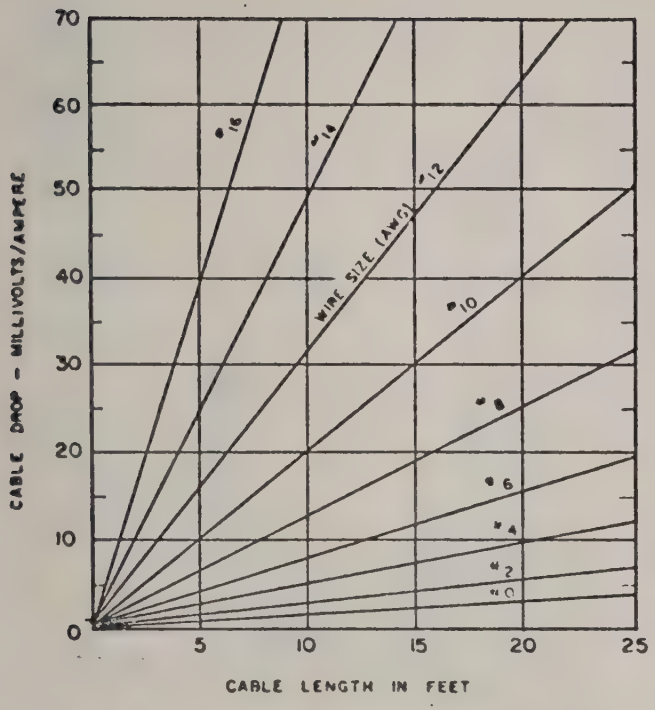
5-7-3. REASSEMBLY. Reassemble the power supply in reverse procedure to that used in disassembly. Be sure to fasten all screws with locking hardware and tighten snugly. Refer to Figures 11 and 12 for complete parts placement diagrams. Upon completion of reassembly refer to paragraph 5-6, Performance Verification, for checking out operation of the power supply.

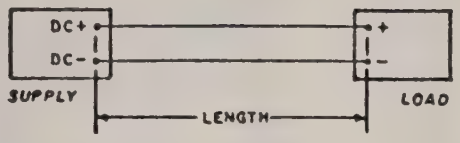
5-8. PACKING FOR RESHIPMENT.

When packaging a power supply for reshipment, roll up the power cord (if equipped) and tie it securely. To prevent scratching and keep out dampness the system may be tied in a plastic bag prior to sealing in a cardboard box. A dessicant may be added to the plastic bag to absorb moisture. The shipping container may be a corrugated, cardboard box tailored to fit the supply snugly or fitted with wadding or extra pieces of cardboard. The power supply should not be loose in its shipping container. Mark container adequately as to contents.

5-9. STORAGE INSTRUCTIONS.

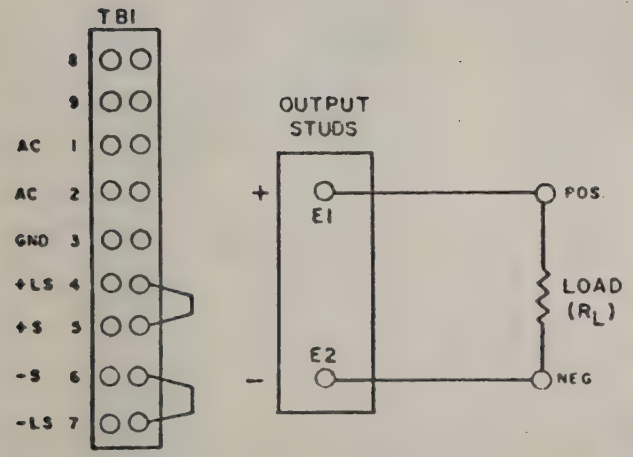
The power supply may be stored open or boxed as in paragraph 5-8. Storage temperature range permissable is $-55^{o}C$ to $+85^{o}C$. If a power supply is to be stored for a long period of time, a waterproof or overseas shipping container should be used. Avoid storage of electronic equipment in damp areas. When reactivating stored systems after eighteen months or more, it is advisable to check performance as in paragraph 5-6, Performance Verification.





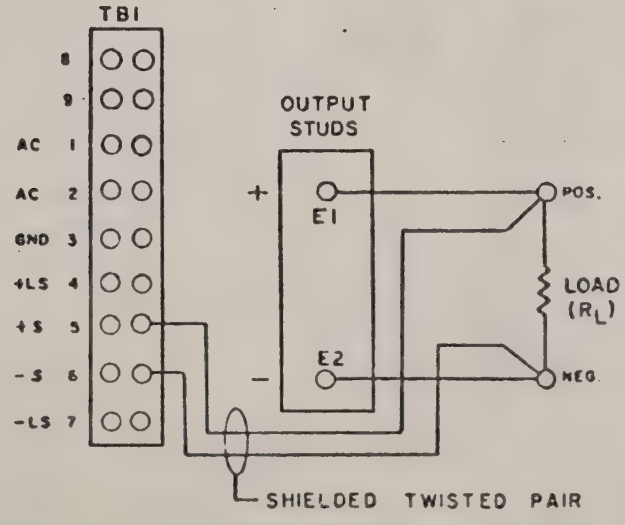
Cable Drop, Millivolts/Ampere, as a Function of Cable Length.

FIGURE 1.



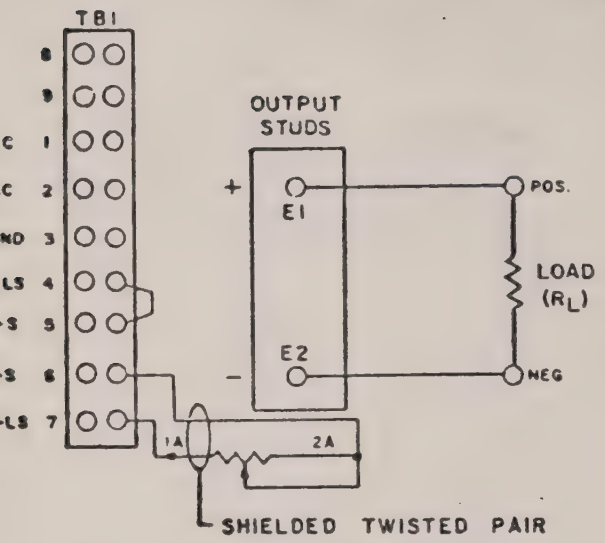
Local Sensing.

FIGURE 2.



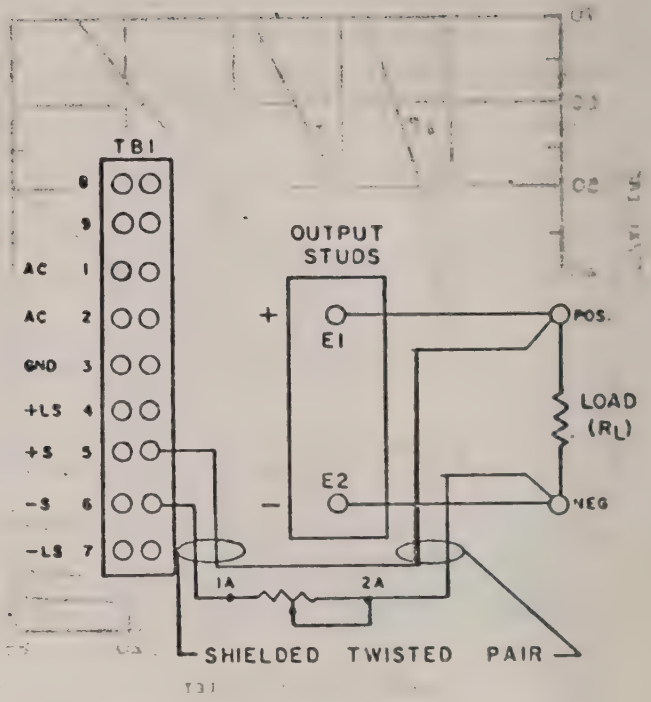
Remote Sensing.

FIGURE 3.



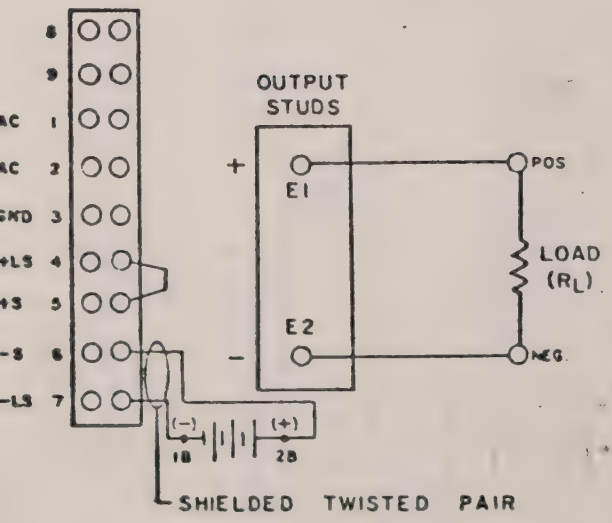
Remote Resistance Programming with Local Sensing.

FIGURE 4.



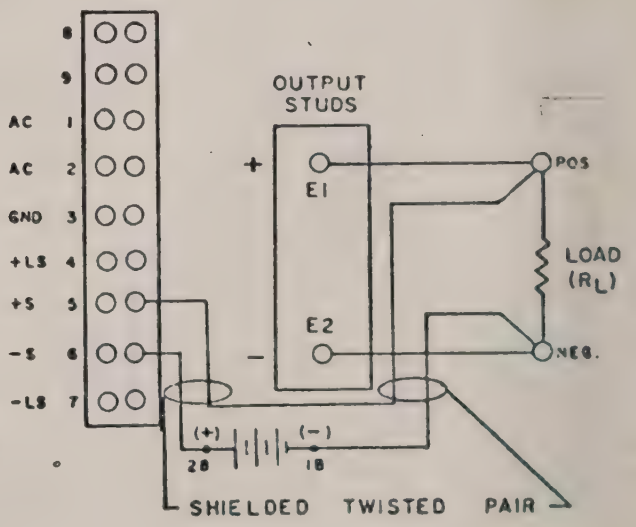
Remote Resistance Programming with Remote Sensing.

FIGURE 5.



Remote Voltage Programming with Local Sensing.

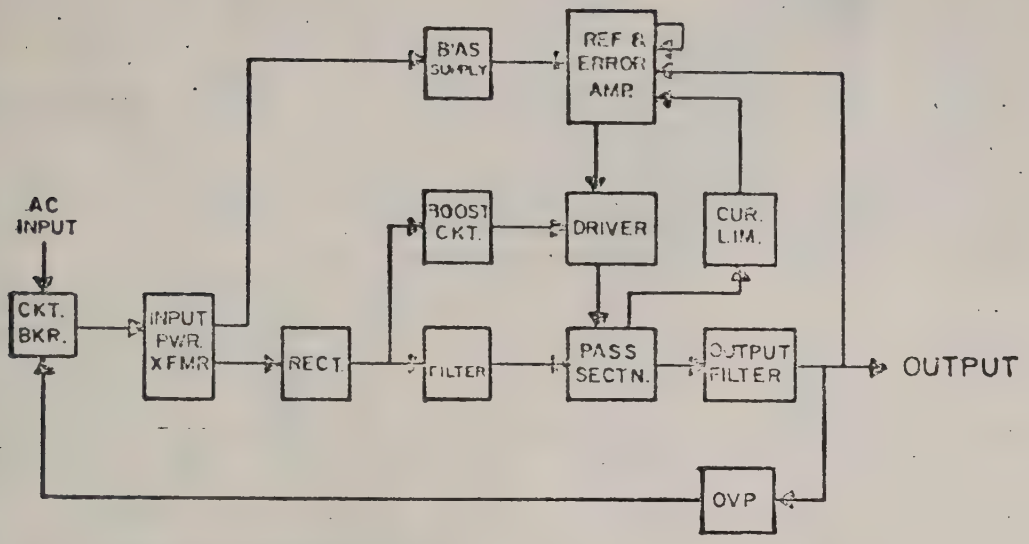
FIGURE 6.



Remote Voltage Programming with Remote Sensing.

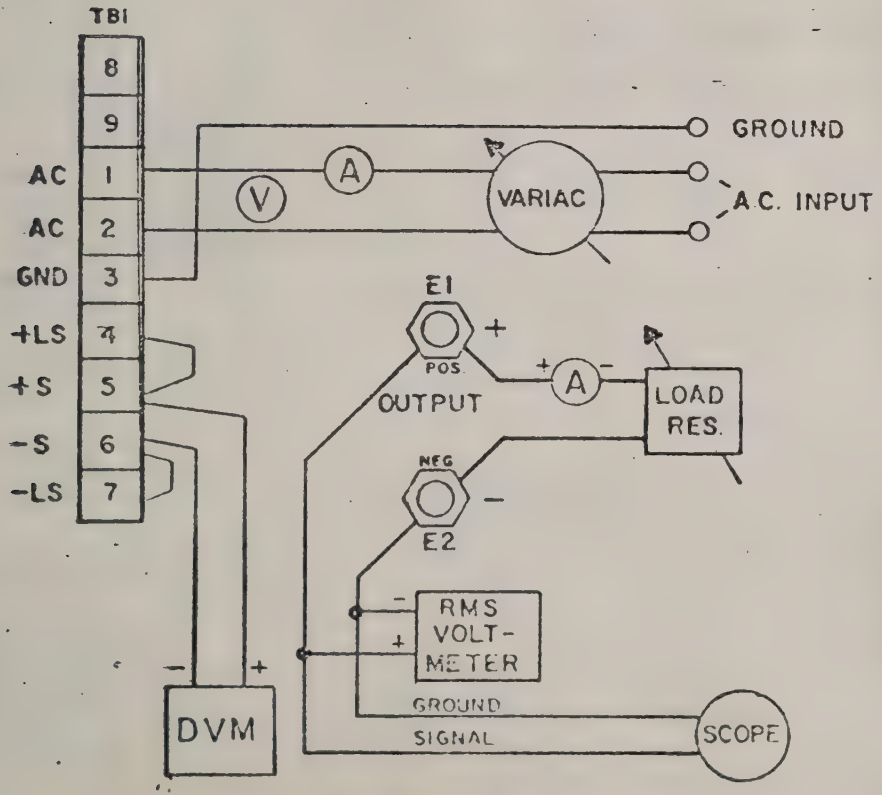
FIGURE 7.

h



General Circuit Block Diagram.

FIGURE 8.



Test Conections for Performance Verification.

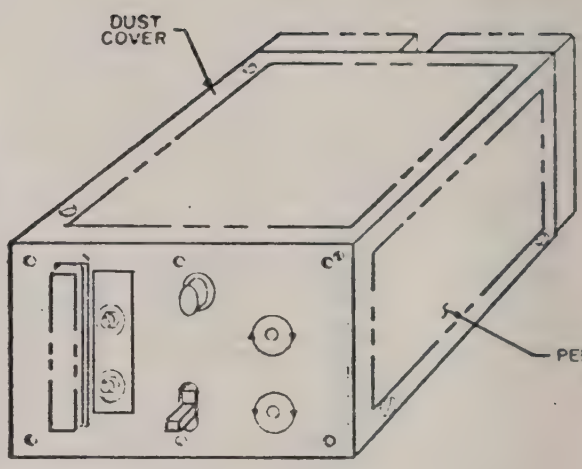
FIGURE 9.

c

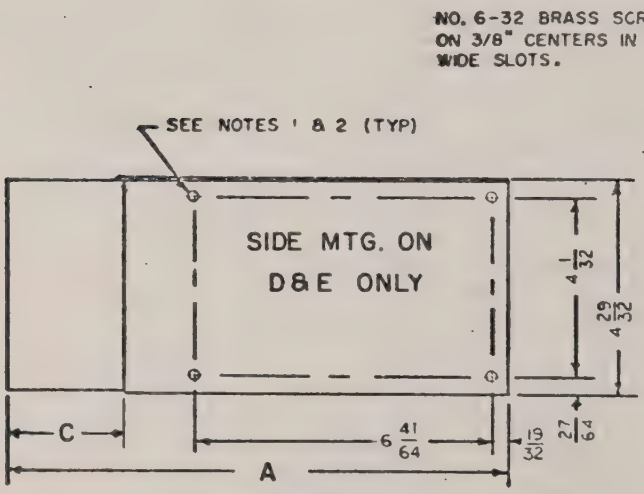
TBI TERMINAL BOARD LEGEND			
TERM NO.	FUNCTION	RECOM'D WIRE SIZE	REMARKS
1	AC		AC
2	AC		AC RETURN
3	G		GROUND
5	+S		JUMPED TO POS OUT
4	+LS		NORMALLY JUMPED TO POS OUT
7	-LS		NORMALLY JUMPED TO NEG OUT
6	-S		JUMPED TO NEG OUT
8			SPARE
9			SPARE
E1	POS OUT		POSITIVE OUTPUT
E2	NEG OUT		NEGATIVE OUTPUT

NOTES

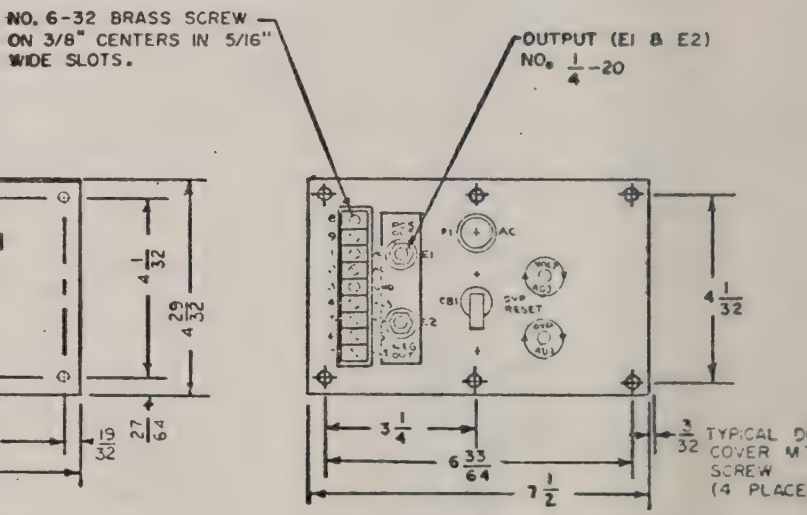
1) NO. 8-32 THREADED MOUNTING HOLES. (TYP 14 PLACES)
2) RECOMMENDED SCREW LENGTH IS 3/8" LONG PLUS THICKNESS OF MOUNTING SURFACE.
3) ALL DIMENSIONS ARE ± 1/64".



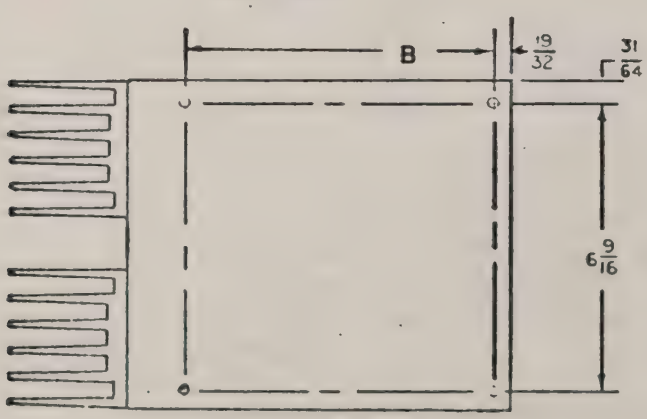
TERMINAL BOARD END



SIDE VIEW



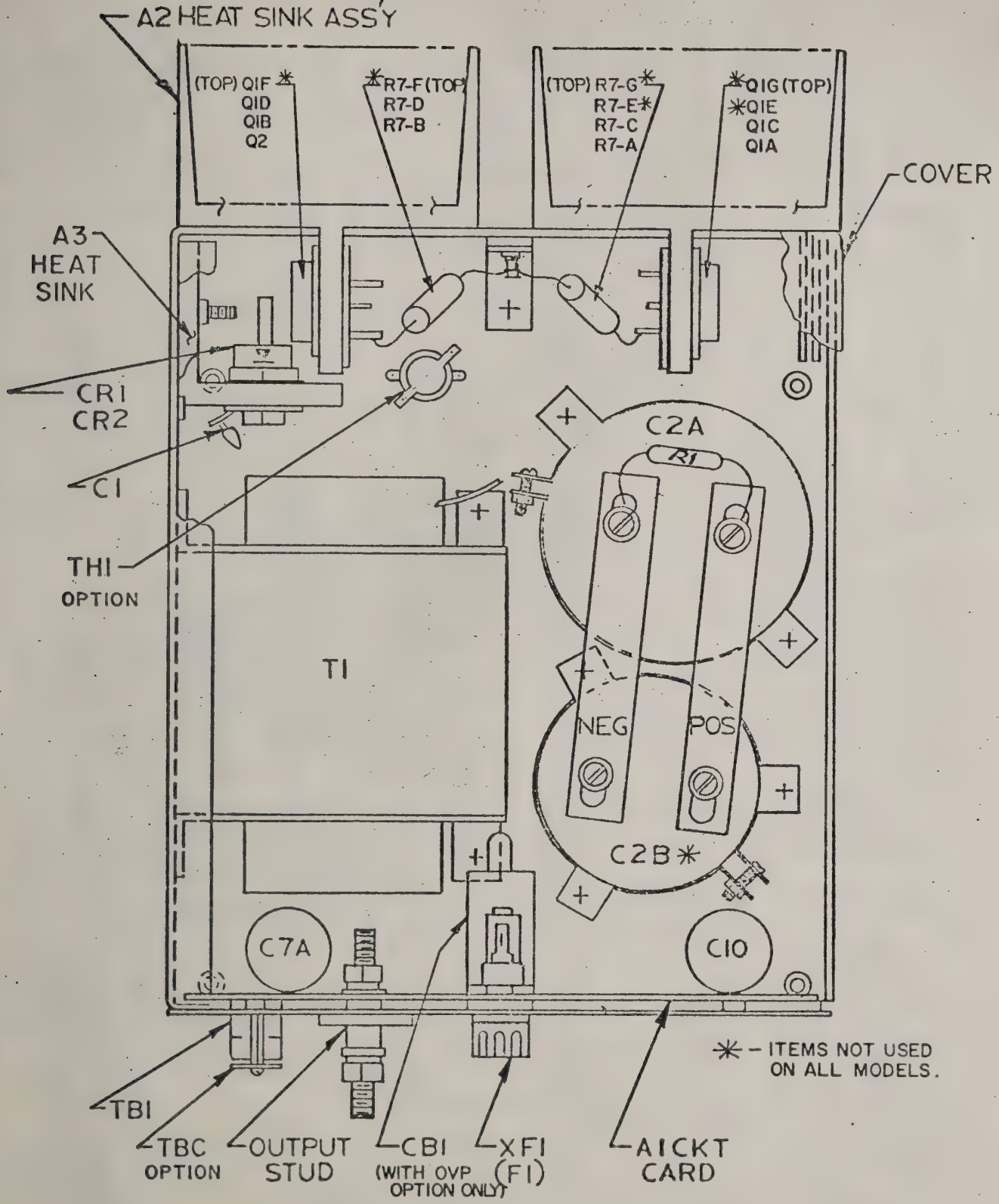
FRONT END VIEW



BOTTOM VIEW

CASE SIZE	DIMENSIONS		
	A	B	C
D	9 51/64	6 57/64	51/64
E	11 3/4	6 57/64	2 3/4
EE	16 1/2	12 3/8	2 3/4

RJ, RS2, RX2
CASE D, E & EE
OUTLINE AND INTERFACE DRAWING
FIGURE 10.



RJ, RS2, RX2

CASE D, E, & EE

PARTS PLACEMENT DIAGRAM

FIGURE II.

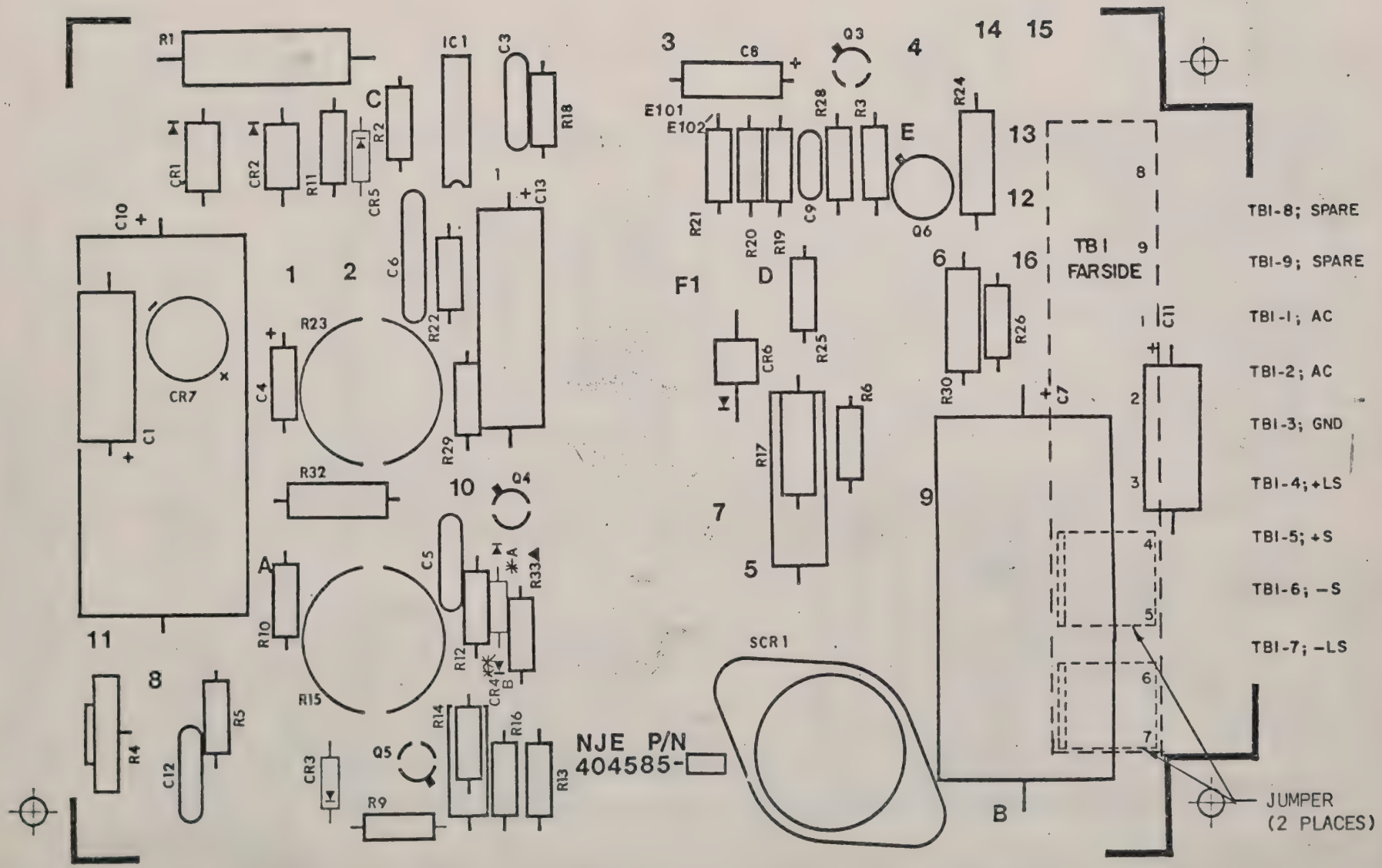


FIGURE 12
PARTS PLACEMENT — AI CIRCUIT CARD
RJ/RS2/RX2-D, E, EE SERIES

NOTES:
"▲" – R33 NOT USED ON ALL MODELS.
"*" – CR4A, USED ON 2V & 5V UNITS ONLY.
"**" – CR4B, USED ON ALL OTHER UNITS.

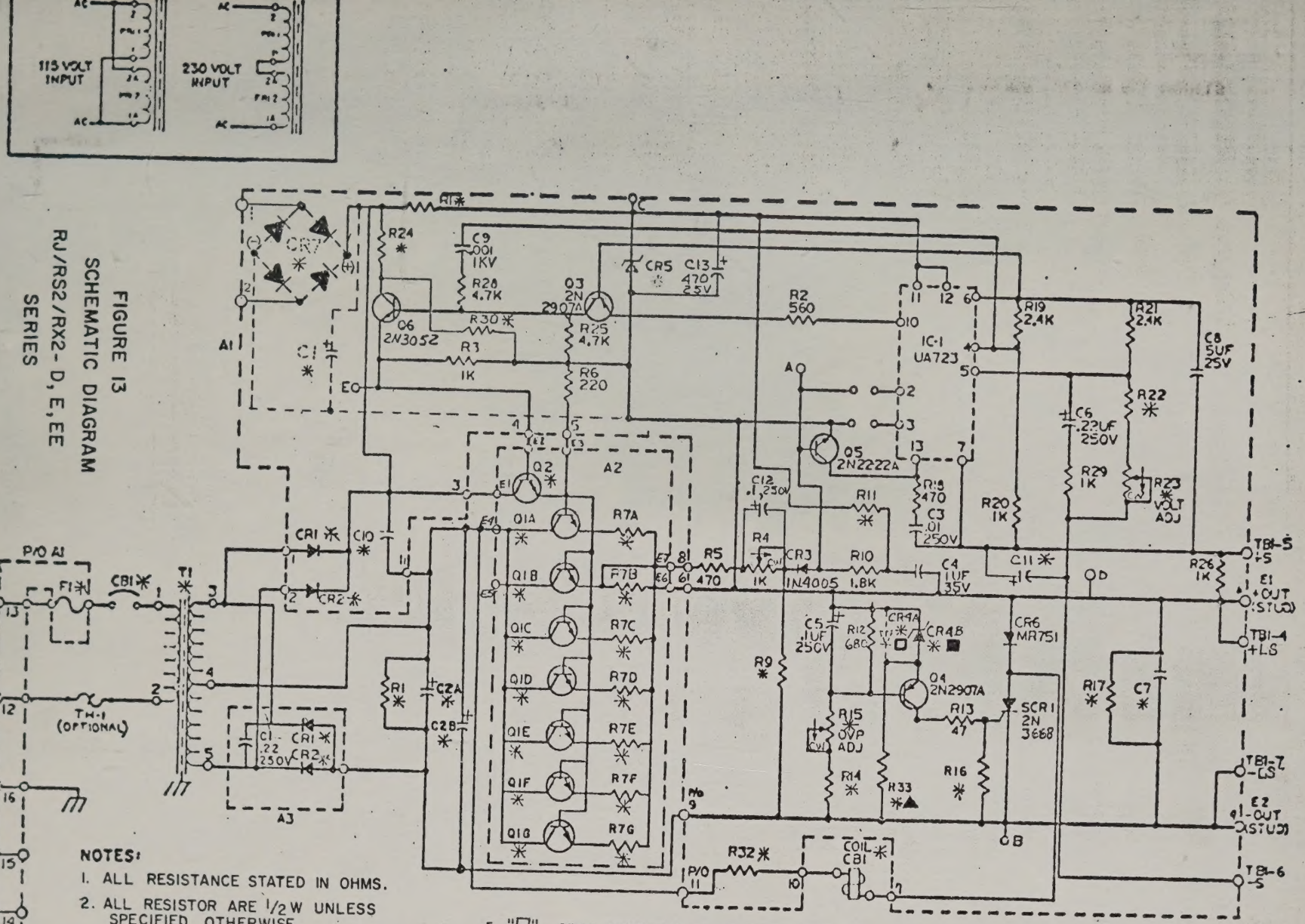


FIGURE 13
SCHEMATIC DIAGRAM
RJ/RS2/RX2- D, E, EE SERIES

NOTES:

1. ALL RESISTANCE STATED IN OHMS.
2. ALL RESISTOR ARE 1/2 W UNLESS SPECIFIED OTHERWISE.
3. "*"—SEE INDIVIDUAL P/L'S FOR VALUES.
4. "▲"—R33 NOT USED ON ALL MODELS.
5. "□"—CR4A USED ON 2V & 5V UNITS ONLY.
6. "■"—CR4B USED ON ALL OTHER UNITS.